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SENSITIVE VALVE VOLTMETER
TYPE 614C

INSTRUCTION BOOK

DAWE INSTRUMENTS LIMITED

97

OPERATING INSTRUCTIONS FOR

SENSITIVE VALVE VOLTMETER
TYPE 614C

DAWE INSTRUMENTS LIMITED
WESTERN AVENUE
ACTON, W.3
ACOrn 6751

Printed in U.K.

DECEMBER, 1961

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1. SCHEDULE OF PARTS

The complete equipment comprises the following parts:—

1.1. One Instrument Type 614C fitted with the following valves:—

Two — EF86 (Mullard) or Z729 (Osram)
Two — EF91 (Mullard) or 6AM6 (Brimar)
One — ECC81 (Mullard) or 12AT7 (Brimar)
One — EL81 (Mullard)
One — 150B2 (Mullard)
One — EZ80 (Mullard)

Also:—

One — Cartridge Fuse 1A for 200-250V operation or 2A for 110V operation (Belling-Lee Type L1055).
One — Indicator Lamp 8V, 0.2A, M.E.S. cap (Vitality G541).

1.2. One — Screened Jack Plug (Igranic P50 with screen A7589).

1.3. One — Terminal Screen with 3-ft. coaxial cable (C8890).

1.4. One — Mains lead complete with 3-pole socket.

1.5. One — Plastic Dust Cover.

1.6. One — Instruction Book IB 614C.

2. DESCRIPTION

2.1. Application.

The Type 614C Sensitive Valve Voltmeter is designed for the measurement of voltages from 80μV to 300V at frequencies between 5 c/s and 100 kc/s. The high input impedance of 10MΩ enables the instrument to be used in measurements associated with high impedance circuits. The instrument is mains operated, extremely compact and portable. It will prove of great value for voltage measurements at frequencies ranging from sub-audio to low ultrasonic. These include vibration studies, frequency response and gain determinations in audio amplifiers, transmission characteristics of filters and output level measurements of oscillators.

2.2. Circuit.

The circuit is essentially a high gain amplifier with a precision attenuator, operating a full wave rectifier and an indicating meter.

The attenuator is arranged in two sections; a high impedance (10MΩ) frequency compensated section at the input to provide a high input impedance and a low impedance section after the first of the two amplifying stages. Both sections are operated by a thirteen position range switch giving full-scale deflections of 300μV, 1mV, 3mV, 10mV, 30mV, 100mV, 300mV, 1V, 3V, 10V, 30V, 100V and 300V. The attenuator section after the first amplifier stage is designed to operate first to improve the signal to noise ratio at higher input levels.

A 1,000V working condenser is used for coupling the INPUT terminals to the first attenuator section, thus providing a.c. voltage measurement when superimposed on d.c., provided the combined peak level does not exceed 1,000V.

Each of the two amplifying stages consist of a two valve circuit giving a gain of about 180, stabilised by 20dB of negative feedback. The stability of the circuit is further enhanced by the use of a low impedance stabilised power supply.

The reading error from hum, noise and microphony is negligible even on the most sensitive range as a result of careful circuit design and the use of a particularly suitable input valve.

The meter responds to the full wave average value of the input signal. The rectifier circuit has been specially developed to keep the meter at earth potential to a.c., thus preventing radiation and interference. A robust meter with a full-scale deflection of 1.3mA is used. The voltage scales are logarithmic and give a constant reading accuracy at all points on the scale. A linear decibel scale is provided with a reference level of 1V and a total range of —82 to +50dB.

3. INSTALLATION

Read the label attached to the instrument and note the information given in respect of the valves and power supply.

3.1. Power Supply.

For supplies other than that stated on the label it will be necessary to adjust the mains selector switch at the rear of the instrument. This is a screwdriver adjustment accessible when the mains lead is unplugged.

Check that the correct fuse is fitted (1A for 200-250V operation and 2A for 110V operation).

With the MAINS switch in the off position connect to the the mains supply with the lead provided.

Red	...	...	Mains (Line)
Black	...	...	Mains (Neutral)
Other Colour	...	...	Earth

3.2. Valves.

These are normally supplied fitted in their holders. The various types used are listed in Section 1.1.

4. OPERATION

4.1. **General.**

Switch the MAINS to ON and note that the red indicator lamp glows. Five minutes should be allowed for the valve heaters to warm up. However, when first put into operation, or after standing idle for a long time, the instrument should be run for at least 30 minutes before use.

Before taking measurements and when making or removing connections to the INPUT terminals, the range switch should be turned fully clockwise, that is, to the 300V range, in order to afford maximum protection to the instrument against overload or transient surges.

WARNING: Mechanical Zero.

The voltage scales are logarithmic and the meter is provided with mechanical bias adjustment to off-set the zero reading. The bias adjustment screw, located on the meter front, should not be touched unless the instrument gives false indications in the low region of the scales.

This can be checked by applying a signal to the INPUT terminals, so as to obtain a reading of 10 on the red dB scale, and switching to the next higher range. The reading should be 0dB. If any discrepancy exists the mechanical bias screw should be adjusted until the meter reads exactly 0dB. Repeat this procedure until correct 0dB and 10dB readings are obtained.

By this method the scale linearity can be re-set to within 2% which is the maximum error between any two adjacent settings of the attenuator switch. When greater accuracy is required the adjustment must be carried out as given in Section 5.3.

4.2. **Voltage Measurements.**

The range to be used is selected by the range switch which provides the following information relating to the meter indication:—

(a) The voltage corresponding to full-scale deflection.
(b) The correct voltage scale to use on the meter.
(c) The number of dB to be added to the meter dB scale.

The decibel scale is calibrated relative to 1V, which is equivalent to 1mW into 1kΩ. The following table gives the conversion factors required when changing the reference level.

Reference Level	*Conversion from dB re. 1V (1mW in 1kΩ)*
0.775V, 1mW in 600Ω	Add 2.2dB
1.732V, 6mW in 500Ω	Subtract 4.8dB
1.897V, 6mW in 600Ω	Subtract 5.6dB

Switch to the 300V range and connect the INPUT terminals to the voltage to be measured. Set the range switch to the required full scale value.

Alternating voltages with superimposed d.c. may be measured, provided the combined peak level does not exceed 1,000V.

Where possible, measurements should be made at a low impedance level in the test circuit, to minimise errors caused by the additional loading of the voltmeter.

The input impedance is equivalent to a resistance of 10MΩ in parallel with a capacitance of approximately 34pF up to the 10mV range and with a capacitance of about 13pF on the higher ranges.

Connecting leads should be as short as possible, particularly at high frequencies. Reasonably long leads may be used at low frequencies, but for low level determination they should be screened to avoid direct hum pick-up.

A terminal screen fitted with 3-ft. of coaxial cable is supplied for use when measuring low signal levels in high impedance circuits. This adds about 60 pF to the input capacitance.

The meter is calibrated in r.m.s. values for a sine-wave input, the indications being proportional to the full wave average value.

4.4. **Output Jack.**

An OUTPUT jack is provided to monitor the signal and to enable the instrument to be used as a high gain amplifier, the maximum amplification available being about 88dB—about 27,000 times. The amplifier output is approximately 8V r.m.s. at full scale deflection into a minimum load resistor of 10kΩ. The source impedance is approximately 20Ω. When measuring small voltages in high impedance circuits or at high frequencies, a screened output lead is required to prevent coupling between input and output leads. The screened output jack supplied with the instrument should be used.

5. MAINTENANCE

5.1. **Removal of Side Covers.**

Disconnect the instrument from the mains supply before attempting to remove the covers.

To gain access to the chassis, unscrew the single 4B.A. chromium screw immediately above the DAWE name plate at the bottom of both front and rear panels.

Remove the metal bezels by grasping the bottom edge and pulling forward and upward.

Grasp the top edge of one side cover and pull outwards to remove it completely. Similarly remove the other side. The valves and chassis components are then readily accessible.

5.2. **Valves and Indicator Lamp.**

The valves and the lamp are standard commercial types and do not normally require selection. The various types used are listed in Section 1.

If it becomes necessary to change V1-V7, the amplifier gain should be checked as described in Section 5.3.

If the stabiliser valves V5-V7 are changed the h.t. at the cathode of V5 should be checked (limits 235 to 255V).

5.3. **Amplifier Gain.**

An internal gain control R24 is provided and is located on the valve chassis between V3 and V4.

Adjustment should not be attempted unless accurate calibration facilities are available.

However, if the accuracy is suspect when valves are changed the following procedure should be adoped:—

(a) Set the MAINS switch to ON and allow the instrument to stabilise for 15 minutes.

(b) Measure the stabilised h.t. at the cathode of V5 to ensure that it is between 235 and 255V.

(c) Set the range switch to a convenient range and compare the meter full scale reading (+10dB) with an accurate standard voltmeter when the same signal voltage is applied to both instruments. The signal frequency should be between 50 c/s and 1 kc/s with a total distortion of less than 1%. If necessary, adjust R24 to align the instrument with the standard voltmeter. Reduce the input signal by exactly 10 dB and adjust the meter mechanical zero screw to align the instrument at exactly 0dB. Re-check the full scale reading. With the scale linearity correctly adjusted re-check the full scale readings on other ranges of the Type 614C and adjust R24 to the mean difference of the required sensitivity to minimise the error due to the attenuator tolerance of ± 1%.

6. SPECIFICATION

Voltage Range: Thirteen voltage ranges are provided with full-scale meter deflections of 300μV, 1mV, 3mV, 10mV, 30mV, 100mV, 300mV, 1V, 3V, 10V, 30V, 100V and 300V.

Accuracy: Better than $\pm$ 2% of indication on all ranges with a sinusoidal input.

Frequency Error: Less than $\pm$ 3% from 5 c/s to 100 kc/s.

Input Impedance: Approximately equivalent to a resistance of 10MΩ in parallel with a capacitance of approximately 34 pF up to the 10mV range and with a capacitance of about 13 pF on higher ranges.

Scale Calibration: Meter calibrated in r.m.s. values for a sine-wave input, the indications being proportional to the full-wave average value.

Amplifier Output: Approx. 8V r.m.s. at F.S.D. into a minimum load resistor of 10kΩ. Source impedance 20Ω approximately. Maximum gain about 88dB. (Approx. 27,000 times).

Power Supply: 110V and 200-250V, 50-60 c/s, 40W approximately.

Mounting: Compact portable metal cabinet finished black with polished bezels.

Dimensions: 6½ in. x 10 in. x 9½ in. high.
(165 mm x 255 mm x 244 mm).

Weight: 14 lb (6.4 kg) approximately.

7. GUARANTEE

Our Products are carefully inspected and submitted to comprehensive tests at our factory before despatch. We therefore give to all purchasers (subject to the terms of payment and all the customer's other obligations being strictly observed) the following guarantee, which excludes and takes the place of any condition or warranty implied by Statute or otherwise.

If within three years from the date of despatch, any defect is discovered in any apparatus in respect of material or workmanship and reasonably within our control, we undertake to make good the defect at our own expense, provided notice is given to us as soon as it is discovered, and that the apparatus is immediately forwarded to our factory, carriage paid and with seals unbroken. Our responsibility is in all cases limited to the cost of making good the defect in the apparatus itself. This guarantee is given to our customers and does not extend to third parties, nor does it apply to defects caused by wear and tear, abnormal conditions of working, accident, misuse or neglect.

In the case of material or components not of our manufacture, we are prepared to give the customer the benefit of any guarantee given us in respect thereof.

8. SERVICING PROCEDURE

The information given in this booklet should enable the user to maintain the equipment in proper working order. If difficulties arise, please write or telephone our Service Department or our Representative or Agent for your area or country. In certain cases we may be able to arrange for an outside service engineer to call on you.

When contacting our Service Department please mention the serial and type numbers of your instrument and include a full report of the fault encountered, as well as details of the action taken to eliminate it.

This information should be addressed to:—

Service Department,
Dawe Instruments Ltd.,
Western Avenue, Acton, London, W.3
Telephone No. Acorn 6751

If the equipment is returned for service, please include a copy of any relevant correspondence, together with all the accessories and the Instruction Book.

This procedure will facilitate the work of our Service Department and expedite the return of the instrument.

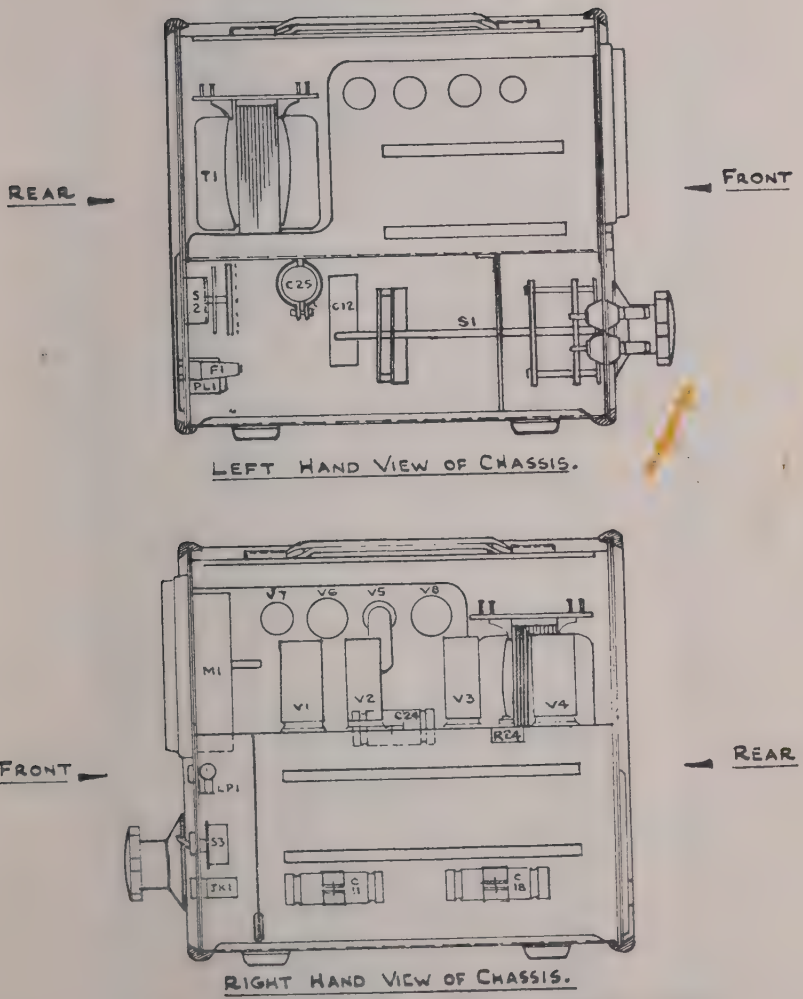


Fig. 1. LOCATION OF MAJOR COMPONENTS (C9328)

CIRCUIT COMPONENTS LIST

Ref.		RESISTORS	Tol.
R1	338kΩ	Welwyn Type C22	±1%
R2	10MΩ	Welwyn Type C24	±1%
R3	9.7kΩ	Welwyn Type C22	±1%
R4	316Ω	Welwyn Type C22	±1%
R5	22MΩ	Welwyn Type C23	±5%
R6	22MΩ	Welwyn Type C23	±5%
R7	8MΩ	Welwyn Type C24	±1%
R8	5MΩ	Welwyn Type C24	±1%
R9	220kΩ	Erie Type 9	±10%
R10	47kΩ	Welwyn Type C22	±5%
R11	120kΩ	Welwyn Type C22	±5%
R12	470Ω	Welwyn Type C22	±5%
R13	1MΩ	Erie Type 9	±10%
R14	150kΩ	Welwyn Type C22	±1%
R15	33kΩ	Erie Type 8	±10%
R16	330Ω	Erie Type 9	±10%
R17	150kΩ	Welwyn Type C22	±1%
R18	47kΩ	Welwyn Type C22	±1%
R19	15kΩ	Welwyn Type C22	±1%
R20	6.94kΩ	Welwyn Type C22	±1%
R21	4.7kΩ	Erie Type 9	±10%
R22	150kΩ	Erie Type 9	±10%
R23	33kΩ	Erie Type 8	±10%
R24	100Ω	Pot. Colvern CLR.1106/9S	—
R25	220Ω	Welwyn Type C22	±5%
R26	1MΩ	Erie Type 9	±10%
R27	330Ω	Erie Type 9	±10%
R28	22kΩ	Erie Type 8	±10%
R29	33kΩ	Welwyn Type C22	±5%
R30	220Ω	Erie Type 9	±10%
R31	4.7kΩ	Erie Type 8	±10%
R32	100kΩ	Erie Type 9	±10%
R33	2.7kΩ	Welwyn Type C22	±5%
R34	470kΩ	Erie Type 9	±10%
R35	1MΩ	Erie Type 9	±10%
R36	68kΩ	Welwyn Type C22	±2%
R37	100kΩ	Welwyn Type C22	±2%
R38	1MΩ	Erie Type 9	±10%
R39	1kΩ	Erie Type 9	±10%
R40	100kΩ	Erie Type 9	±10%
R41	100Ω	Erie Type 9	±10%
R42	2.2kΩ	Erie Type 8	±10%
R43	1MΩ	Erie Type 9	±10%
R44	15kΩ	Welwyn Type AW.3111	±5%
R45	3.9kΩ	Erie Type 8	±10%
R46	100Ω	Erie Type 9	±10%
R47	100Ω	Erie Type 9	±10%
R48	470Ω	Erie Type 9	±10%
R49	10kΩ	Erie Type 8	±10%

Ref.		CAPACITORS		Tol.	Working Voltage
C1	0.05μF	Hunts Type AF.118	... ...		1000
C2	68pF	Dubilier Type S.635	... ...	±20%	350
C3	2.5-50pF	Oxley Type A7/475	... ...		500
C4	4000pF	Hunts List No. H.1355A	... ...	±10%	500
C5	1.25-5pF	Wingrove and Rogers C.32.01	...		500
C6	0.05μF	Hunts List No. A.305	... ...	±20%	250
C7	1μF	Hunts List No. A.309	... ...	±20%	250
C8	0.05μF	Hunts List No. A.305	... ...	±20%	250
C9	1μF	Hunts List No. A.309	... ...	±20%	250
C11	32-32μF	T.C.C. Type CE.34HE	... ...		275
C12	2μF	Hunts List No. A.310	... ...	±20%	250
C13	2pF	T.C.C. Type SCP.4	... ...		500
C14	25pF	Dubilier Type S.635	... ...	±20%	350
C15	68pF	Dubilier Type S.635	... ...	±20%	350
C16	1μF	Hunts List No. A.309	... ...	±20%	250
C17	1μF	Hunts List No. A.309	... ...	±20%	250
C18	40-40μF	Hunts List No. J.3161.T.	... ...		150
C19	0.1μF	Hunts List No. A.305	... ...	±20%	250
C20	2000μF	T.C.C. Type CE.26AE	... ...		6
C21	2μF	Hunts Type No. A.304	... ...	±20%	150
C22	0.1μF	Hunts Type No. A.306	... ...	±20%	250
C23	0.1μF	Hunts Type No. A.306	... ...	±20%	250
C24	16-16μF	T.C.C. Type CE35PE	... ...		350
C25	24μF	T.C.C. Type CE.10P	... ...		450
C26	470pF	Dubilier Type S.635	... ...	±20%	350
C27	1.25-5pF	Wingrove and Rogers C.32.01	...		500

Circ. Ref.	MISCELLANEOUS
V1	EF86 Mullard Valve or Osram Z.729
V2	EF91 Mullard Valve or Brimar 6AM6
V3	EF91 Mullard Valve or Brimar 6AM6
V4	ECC81 Mullard Valve or Brimar 12AT7
V5	EL81 Mullard Valve
V6	EF86 Mullard Valve or Osram Z.729
V7	150B2 Mullard Valve
V8	EZ80 Mullard Valve
M1	Sangamo Weston S.157.1.2191 to Drg. C.10197
W1	Crystal Diode Type CV.448
W2	Crystal Diode Type CV.448
JK1	Igranic Type P.72
PL1	Bulgin QS.593
F1	Belling Lee L.1055 1A for 200-250 V. 2A for 110 V.
P1	8 V. 0.2A Mes. Cap. Vitality G.541
T1	Partridge Type D.5742P.
S1	N.S.F. to D1 Drg. No. C.9001
S2	N.S.F. to D1 Drg. No. C.9135
S3	Cutler Hammer 8370/KB (D.P.S.T.)

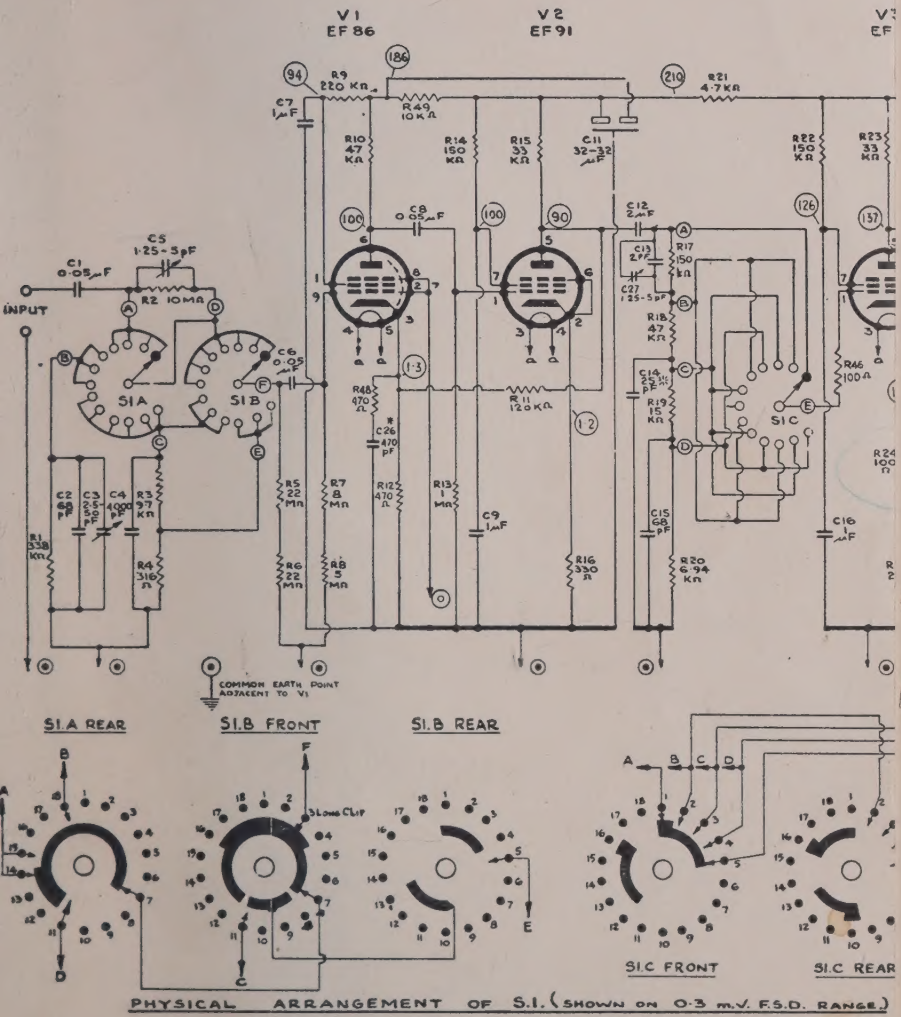
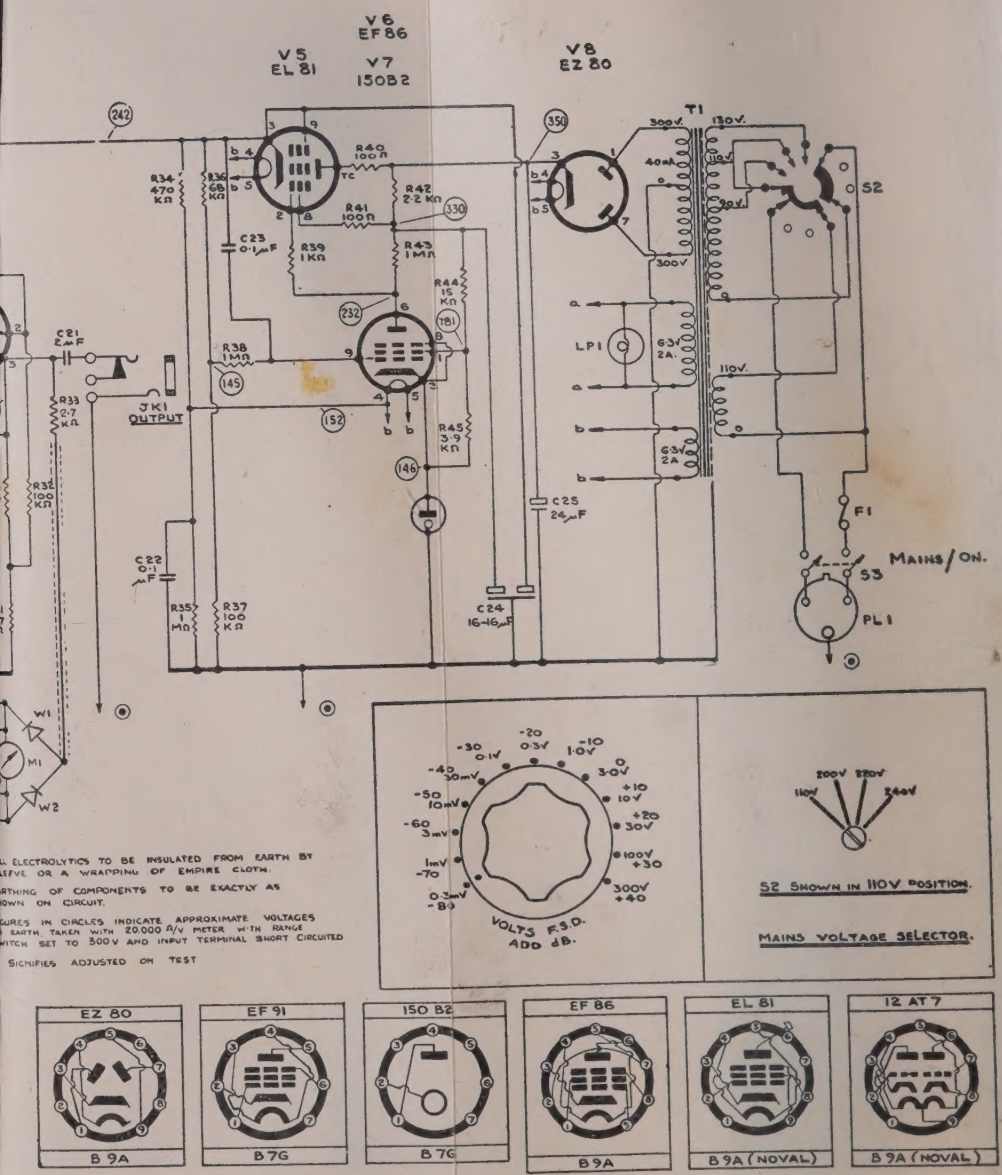

V1
EF 86
V2
EF 91
INPUT
S1A
S1B
S1C
COMMON EARTH POINT ADJACENT TO V1
S1.A REAR
S1.B FRONT
S1.B REAR
S1.C FRONT
S1.C REAR
PHYSICAL ARRANGEMENT OF S.1. (SHOWN ON 0·3 m.V. F.S.D. RANGE.)

Fig. 2



L ELECTROLYTICS TO BE INSULATED FROM EARTH BY
LEFVE OR A WRAPPING OF EMPIRE CLOTH.
RTHING OF COMPONENTS TO BE EXACTLY AS
OWN ON CIRCUIT.
GURES IN CIRCLES INDICATE APPROXIMATE VOLTAGES
EARTH TAKEN WITH 20000 Ω/V METER WITH RANGE
WITCH SET TO 300 V AND INPUT TERMINAL SHORT CIRCUITED
SIGNIFIES ADJUSTED ON TEST

AGRAM (E9298)

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